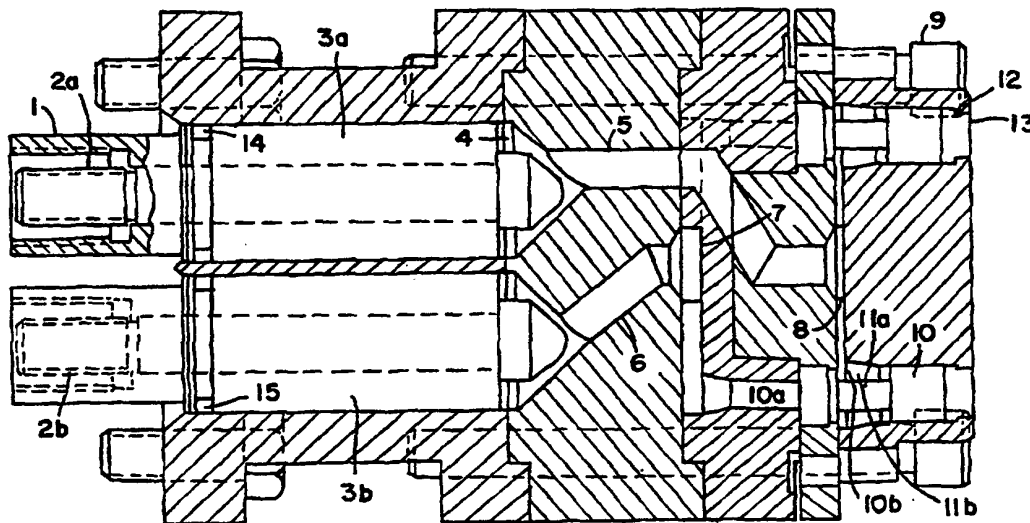


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: MULTICHARACTERISTIC EXTRUDED ARTICLES AND PROCESS AND APPARATUS



## (57) Abstract

A process and apparatus for the production of an extruded article having two or more distinct characteristics, and which are capable of producing such an extruded article wherein differing characteristics, such as color, texture, taste and the like, can be positioned as desired in the extruded article. The apparatus is equipped with a pair of mixing screws (2a, 2b) which are situated in their respective mixing barrels (3a, 3b). Each of the mixing barrels (3a, 3b) is arranged and connected in flow path communication with a common manifold (4), which in turn is arranged and connected in flow path communication with two or more flow stream conduits (5, 6) which receive the respective flow streams from the barrels/mixing screws portion (2a, 2b, 3a, 3b) of the extruder, the streams then being fed into their respective distributor cavities (7, 8) which are in communication with extrusion means (9) having recombining means (10) and die means (13).

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# "MULTICHARACTERISTIC EXTRUDED ARTICLES AND PROCESS AND APPARATUS"

## FIELD OF THE INVENTION

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This invention relates to extrusion devices for working food compositions and plastic materials, and in particular to the manufacture of articles possessing multicharacteristics such as food products or the manufacture of plastic articles from thermoplastic materials.

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## BACKGROUND OF THE INVENTION

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Conventional extrusion methods and apparatus such as for use in the manufacture of food products and plastic articles from thermoplastic materials, are all generally manufactured in the same way. In particular, extrusion units generally are equipped with a screw device which is rotatably mounted in a sleeve, the end of which is fitted with a die device which is designed and responsible for producing the design features and characteristics of the shape of the finished product, i.e., its permanent profile, be it a plastic decorative article of a distinctive design and color, or monofilament fibers, or a food product having such characteristics, for example, such as cereal products and other assorted prepared foods articles. The unit rotating screw device-sleeve arrangement, which is oftentimes heated, can act as a mixer to mix and melt various materials, or in the case of food, in addition to mixing, to cook or gelatinize, such as starch, or otherwise work on ingredients or different thermoplastic materials and various additives such as colorants and adjuvants and the like as desired in a particular composition to compose the final material. This unit can additionally act as a pump to force the mixed, cooked or plasticized product through the die to produce a product having a desired profile.

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Extrusion methods to manufacture bicomponent or multicomponent articles or other articles having two or more different characteristics such as a bicolored article are known. For example, GB Patent Specification 1253104 describes the manufacture of a multiple extruded cereal product by extruding cooked cereal dough through a die under expanding conditions while simultaneously extruding within the mass of cooked expanded cereal extrudate a center-fill material to produce a shell of cooked expanded cereal containing a filling material. This is accomplished by the use of a first die to produce the shell extrudate and a second die positioned within the orifice of the first die such that the extrudate from the first die completely surrounds the extrudate from the second die.

Up to the present time, however, techniques to produce extruded bicomponent articles or articles possessing a multiplicity of different characteristics have been hampered in their lack of flexibility to produce such articles having the desired pattern of differing characteristics, e.g., different alternating color patterns or schemes or different arrays of specific food ingredients.

It would be highly desirable, therefore, to be able to produce a product having two or more characteristics, for example, a product having variation in appearance, taste and texture, wherein such characteristics can be situated in the product at various locations as desired. For example, a method and apparatus having the flexibility to produce a product having a pattern of two or more alternating colors or components of a different texture and taste sensation and the like would be highly desirable.

It is therefore an object of the present invention to provide such a process and apparatus, and to remedy the aforementioned undesirable limitations, inflexibilities and drawbacks of conventional extrudate techniques.

#### SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a process for the production of an extruded article

having two or more distinct characteristics, and which has the capability of producing such an article wherein the differing characteristics, such as color, texture, taste and like, can be positioned as desired in the article. In one embodiment, the process comprises separating the flow stream in or from an extrusion means, for example, an extrusion mixer, into at least a first flow stream and a second flow stream, and then altering the characteristics of at least one of the first and/or second flow streams by the addition thereto of material foreign to the first and second flow streams such as coloration material, or material having the same composition as the first and second streams but having different characteristics due to its physical nature (all generally referred to herein as "characteristic alternating material"), and then simultaneously driving each flow stream through an extruding means comprising a recombining means and a die means. The recombining means has an array of segregated orifices wherein one or more of each of the segregated orifices is adapted to receive a respective portion of each flow stream separately, and with the respective flow streams thereafter flowing through each of the respective orifices arranged in the combining means, and then through a die means to produce a multicharacteristic extruded article. The particular array of multicharacteristics in the extruded article is dictated by the array of segregated orifices in the recombining means, and its shape is characteristic of the die means.

In another embodiment, the process of the present invention comprises separating the flow stream in or from an extrusion means into a plurality of separate flow streams, for example, three or more flow streams ( $n + 2$  flow streams with  $n$  being an integer equal to one or more), then altering the characteristics of one or more of the flow streams as desired by the addition thereto of characteristic altering material, and then simultaneously driving at least two of the separated flow streams through an extrusion means comprising a recombining means and a die means.

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Alternatively, all of the separated flow streams can be simultaneously driven through the recombining means or any two of the flow streams can be driven therethrough with the alternating or intermittent addition of other flow streams.

5 The recombining means in this embodiment has an array of segregated orifices, wherein each segregated orifice in the array is adapted to receive a respective portion of each of the  $n + 2$  flow streams, with the respective flow streams passing therethrough, followed by their passage through a die means to produce a multicharacteristic extruded article having its multicharacteristic nature dictated by the array of segregated orifices in the recombining means, and its shape dictated by the die means.

10 The invention will be more fully understood with reference to the following detailed discussion including a discussion of preferred embodiments.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cutaway longitudinal sectional view of one embodiment of apparatus for carrying out the process of this invention.

20 FIG. 2a is a cutaway longitudinal sectional view of one embodiment of a component for use with the apparatus of FIG. 1.

FIGS. 2b and 2c are plan views of the respective ends of the component of FIG. 2a.

25 FIG. 3 is plan view of another component of the apparatus of FIG. 1.

FIG. 4 is a schematic flow chart illustrative of a cutaway partial longitudinal sectional view of another embodiment of apparatus for carrying out the process of the present invention.

30 FIG. 4a is a plan view of an end of a component for use in the apparatus of FIG. 4.

#### DETAILED DISCUSSION

35 Referring now to FIG. 1, there is shown in a longitudinal sectional view one embodiment of an apparatus for carrying out the present inventive process for producing

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articles having at least two different characteristics, for example, colors and/or tastes and the like. This apparatus is particularly suited for use in the prepared food industry, for example, in the manufacture of cereal products. For purposes of simplicity and enhanced clarity in the understanding and appreciation of the present invention, this embodiment is illustrative of one of the simpler designs of apparatus able to carry out the process of this invention. It is to be understood, however, that this detailed discussion of one embodiment of the invention is for illustrative purposes only, and is in no way intended to limit the scope of the specification and claims or the spirit thereof in any way.

Turning now to the apparatus of FIG. 1, a mixer generally shown as 1 is equipped with a pair of mixing screws 2a and 2b which are situated in their respective mixing barrels 3a and 3b. Although a two-screw arrangement is depicted in this illustrative embodiment, a single screw would certainly suffice and a multiplicity of screws, for example three or more, can be used as desired.

The mixer and barrel/screw arrangement is not critical to this invention and any conventional design can be employed. For example, any of the screw and barrel designs such as set forth in the Plasticating Components Technology booklet published by Spirex Corporation of Youngstown, Ohio (Formerly the Screw & Barrel Technology booklet) and Extrusion Communiqué, published quarterly, can be used with the instant invention. However, it has been found through experimentation and optimization studies that some designs of mixing devices are preferred over others for particular applications. In this respect, the mixing device known in the trade as the Maddock mixer is preferred in the extrusion and production of expanded cereal products, although originally designed for the mixing and extrusion of plastic polymeric materials. Due to the necessity in many instances to produce extruded food articles having excellent homogeneity, this design of extrusion screw is preferred as

uncombined ingredients which are not sufficiently combined can be screened out. The Maddock mixer is described in detail on pages 12-13 of the Spir x catalog, which is expressly incorporated by reference herein.

5 Each of the mixing barrels 3a and 3b in mixer 1 is arranged and connected in flow path communication with a common manifold 4, which in turn is arranged and connected in flow path communication with two or more flow stream conduits, conduit means 5 and 6 in FIG. 1, which receive the  
10 respective flow streams from the barrels/mixing screws portion of the extruder. As will be appreciated by those persons skilled in the art, a single screw-mixer design may be employed or a multiple screw-mixer design may be employed which empties its flow stream into a common manifold feeding  
15 into flow stream conduit means, such as 5 and 6, for an initial separation into at least two streams.

Each of the streams in their respective conduit means 5 and 6 is then fed into their respective distributor means, depicted by distributor cavities 7 and 8, which are arranged  
20 and connected to be in flow path communication therewith, and which are situated in an extrusion means shown generally as 9. Each of the distributor cavities 7 and 8 then serve to feed material into respective recombining means.

As shown, in extrusion means 9 there are situated one  
25 or more means for recombining the separated flow streams into one extruded article. The recombining means are shown generally as 10. Each of the recombining means 10 comprise at least one orifice 10a with a connecting flow channel 11a for receiving material from distributor cavity 7, and at  
30 least one orifice 10b with a connecting flow channel 11b for receiving material from distributor cavity 8, and preferably a multiplicity of such orifices 10a and 10b which can be situated in any array or pattern in the recombining means 10 as desired with each of the orifices and their respective  
35 connecting flow channels 11a and 11b being segregated from one another. Orifices 12a and 12b at the opposite ends of the flow channels 11a and 11b then feed the material through

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a die means 13 to form an extruded article having a shape characteristic of the die's features. The extruded article will also have an array of differing characteristics, for example, an alternating color scheme, which is  
5 characteristic of the array or pattern of orifices 10a and 10b and their respective connecting flow channels 11a and 11b provided in the recombining means 10.

As is conventional in the extrusion art, the length of the extruded article can be adjusted as desired such as with  
10 the use of a knife means (not shown) to slice off portions of extruded material as it leaves the die means 13.

The distributor cavity means, shown in this illustrative embodiment as distributor cavities 7 and 8, is not critical to the invention and is merely a preferred  
15 feature. For example, it is contemplated that each of the flow stream conduit means, depicted in this example as 5 and 6, can feed directly into respective orifices of a recombining means. However, as will be appreciated by persons skilled in the art, the use of a distributor cavity  
20 means enables the convenient use of a multiplicity of recombining means each having their respective segregated orifices being fed by material leaving the distributor cavities in flow path communication with their respective stream conduit means. It is contemplated that any type or  
25 design of a distributor means may be employed in the present invention other than using distributor cavities as illustrated. For example, one or more distributor conduit streams connecting the stream conduit means 5 and 6 to each of the respective segregated orifices 10a and 10b in the  
30 recombining means 10 may be employed.

Returning now to the mixing barrels 3a and 3b from which flow material separated into two streams into conduit means 5 and 6 in this illustrated embodiment, it is contemplated that characteristic altering material can be  
35 introduced at any point in the process and preferably into either or both of the streams in the dual mixing barrels if such is employed, or at any point or location in th

apparatus following this point and prior to exit from the die means. As shown in this preferred embodiment, a means for introducing characteristic altering material, such as coloration material, different food ingredients, thermoplastic materials, adjuvants, fillers and the like, into either or both of flow stream conduit means 5 and 6 is depicted as conduit means 14 and 15.

FIG. 2a is a cutaway longitudinal schematic of one embodiment of a recombining means 10 useful in the present invention, and the apparatus of FIG. 1, and FIGs. 2b and 2c illustrate front and rear plan views of this embodiment. As shown, orifices 10a adapted for receiving extrusion flow material from one distributor cavity, for example distributor cavity 7 in FIG. 1, alternate with and are segregated from orifices 10b adapted for receiving extrusion flow material from another distributor cavity, for example, distributor cavity 8 in the apparatus of FIG. 1. Segregated flow channels 11a and 11b in flow path communication with their respective orifices 10a and 10b then lead to outer respective orifices shown generally as 12 through which flow is directed through die means 13, not shown in this FIG., to form a characteristic shape as desired.

FIG. 2b is a plan view of the end of recombining means 10 to which is fitted a die means 13, and where orifices 10b with respective flow channels 11b are indicated with broken lines leading to respective outer orifices 12b. As also shown, orifices 12b alternate in this embodiment with orifices 12a, which are in flow path communication with orifices 10a and flow channels 11a, not shown in this FIG.

FIG. 2c is a plan view of the end opposite to that shown in FIG. 2b of the recombining means 10, showing an orifice 10a.

FIG. 3 shows a plan view of one especially preferred embodiment of a die means from the myriad of possible die means that can be employed in this invention to produce virtually any geometric shape and/or design contemplated. In this embodiment of a die, open areas in the shape of

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"elbows" 20 alternate with a common solid area 22 to produce a uniquely shaped extruded product, for example, an extruded cereal product.

As indicated by arrows 24a and 24b, the die means 13, which is fitted over the face of recombining means 10, shown herein in detail in FIG 2b, can be rotated clockwise or counterclockwise and/or otherwise positioned such that material extrusion streams having different characteristics and which are flowing through respective orifices 12a and 12b will flow through the elbows 20 to produce a shaped article comprising the different characteristics positioned/situated therein as desired.

FIG. 4 is illustrative of a schematic flow chart inclusive of a cutaway partial longitudinal sectional view of another embodiment of an apparatus for carrying out the process of the present invention to produce an article having more than two different characteristics, or  $n + 2$  characteristics. As shown in FIG 4., material from flow stream conduit means 30, 32 and 34, coming from a screw-mixer portion of an extrusion means and having been separated, for example, via a common manifold, into separate flow streams in conduit means 30, 32 and 34 enters respective distributor cavities i, ii and n, thus forming  $n + 2$  flow streams. Each of the distributor cavities i, ii and n then serve to feed material into the recombining means, depicted generally in this embodiment as 36. In this recombining means, orifices 38a, 38b and 38c are in respective flow path communication with distributor cavities i, ii and n to feed material through respective flow channels 40a, 40b and 40c, and then through outer orifices 42a, 42b and 42c to thereafter proceed through a die means indicated generally by broken line 44.

FIG. 4a is a plan view of the end of the recombining means 36 to which is fitted a die means 44 illustrating a possible array of orifices 42a, 42b and 42c.

**WHAT IS CLAIMED IS:**

1. Process for the production of an extruded article having at least two distinct characteristics comprising separating a flow stream of material to be extruded into a first flow stream and a second flow stream, altering the characteristics of at least one of the first and/or second flow streams by the addition thereto of characteristic altering material, simultaneously driving each flow stream through an extrusion means comprising a recombining means having an array of segregated orifices wherein each of the segregated orifices is adapted to receive a respective portion of each flow stream separately, and with the respective flow streams thereafter flowing through each of the respective orifices in the recombining means and then through a die means to produce a multicharacteristic extruded article.

2. The process of claim 1, wherein the positional array of multicharacteristics of the extruded article is determined by the array of segregated orifices in the recombining means, and the shape of the extruded article is characteristic of the die means.

3. Process for the production of an extruded article having three or more distinct characteristics, comprising separating a flow stream of material to be extruded into  $n + 2$  flow streams with  $n$  being an integer equal to one or more, altering the characteristics of one or more of the  $n + 2$  flow streams by the addition thereto of characteristic altering material, simultaneously, intermittently or a combination thereof driving each flow stream through an extruding means comprising a recombining means having an array of  $n + 2$  segregated orifices, wherein each of the segregated orifices is adapted to receive a respective portion of each of the  $n + 2$  flow streams separately, and with the respective flow streams thereafter flowing through each of the respective orifices in the recombining means and then through a die means to produce a multicharacteristic extruded article .

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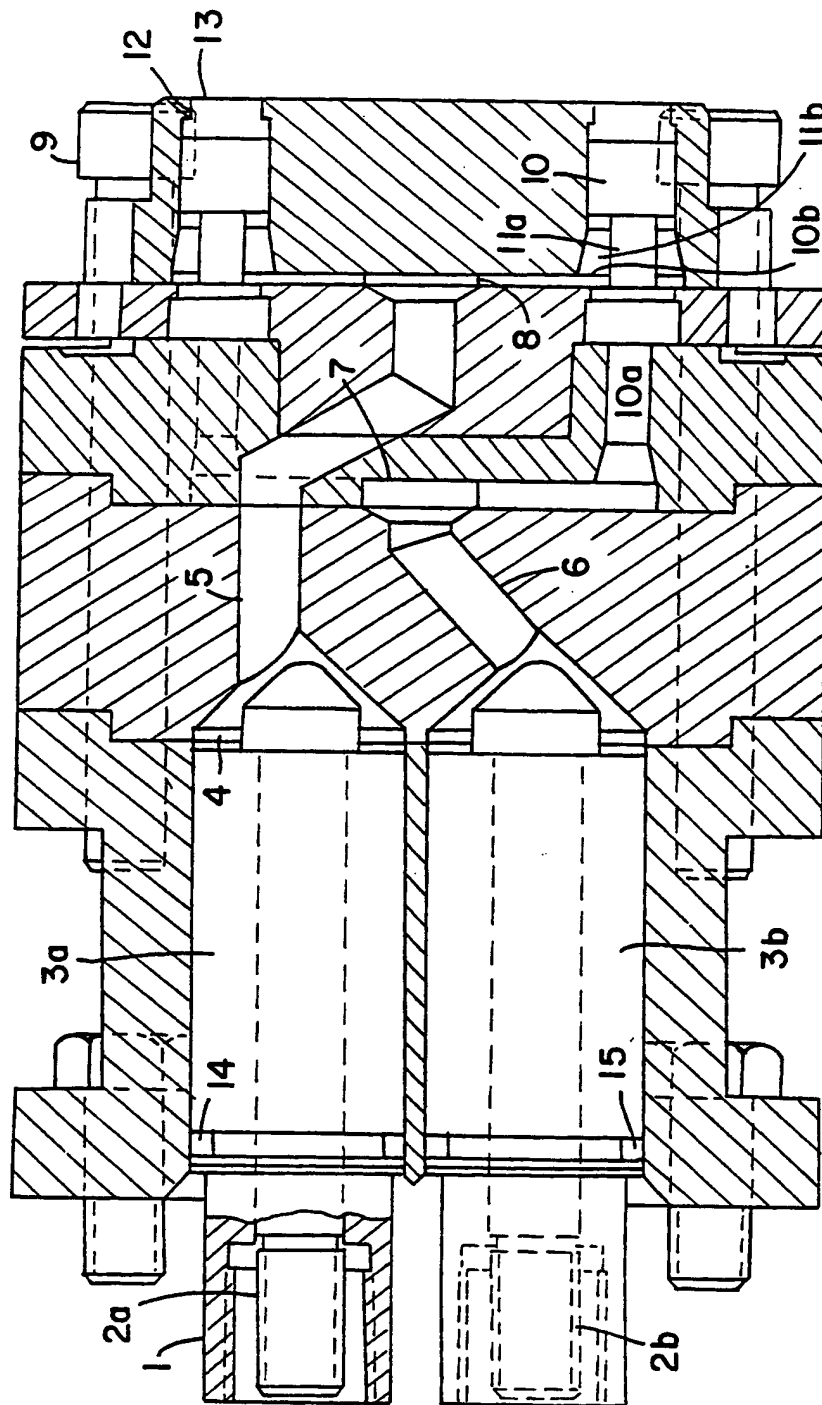
4. The process of claim 3, wherein the positional array of multicharacteristics of the extruded article is determined by the array of segregated orifices in the recombining means and the shape of the extruded article is characteristic of the die means.

5. Apparatus for the production of a multicharacteristic extruded article comprising;  
separation means for separating a flow stream of material to be extruded into  $n + 1$  streams with  $n$  being equal to an integer of one or more;  
flow conduit means for receiving the  $n + 1$  separated streams;  
extrusion means for receiving the  $n + 1$  separated streams from the flow conduit means, wherein the extrusion means comprises one or more recombining means having an array of segregated orifices wherein each orifice is adapted to receive a respective portion of each of the  $n + 1$  separated streams;  
die means adapted to receive the flow from the recombining means;  
and conduit means adapted to introduce characteristic altering material to any point in the apparatus from and including the separation means to and including the die means.

6. A die means having a configuration as shown in FIG. 3.

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FIG. 1



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FIG. 2B

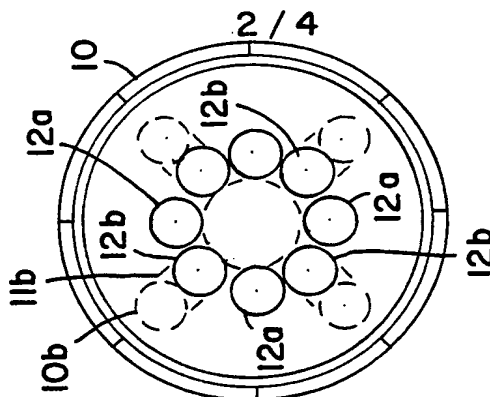


FIG. 2A

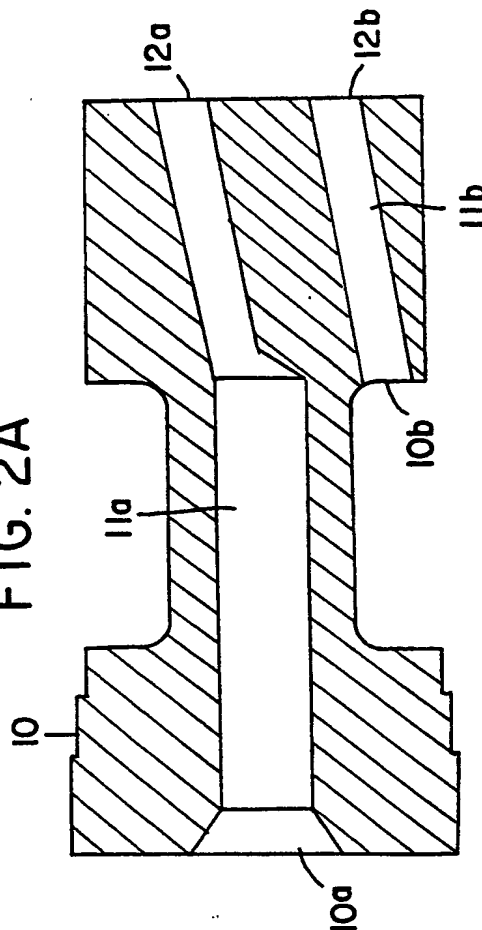
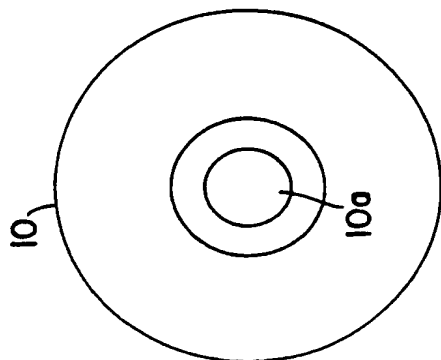
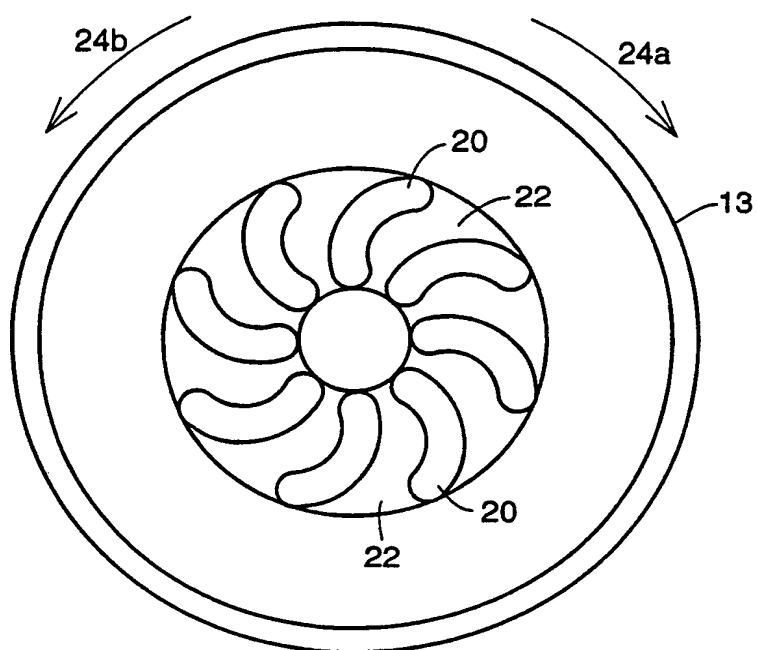


FIG. 2C



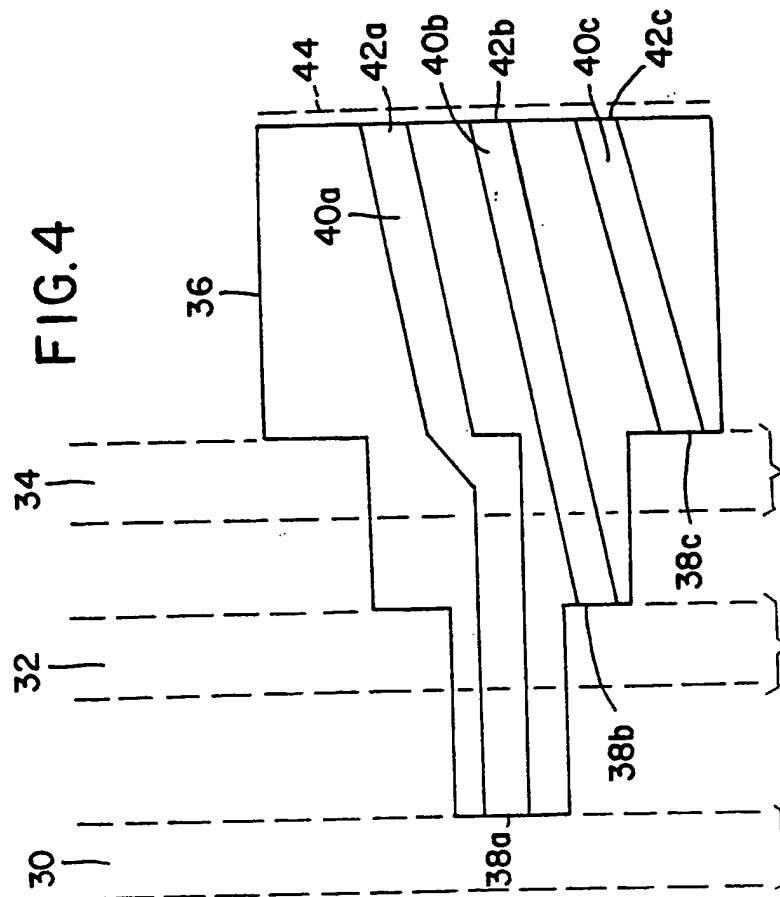
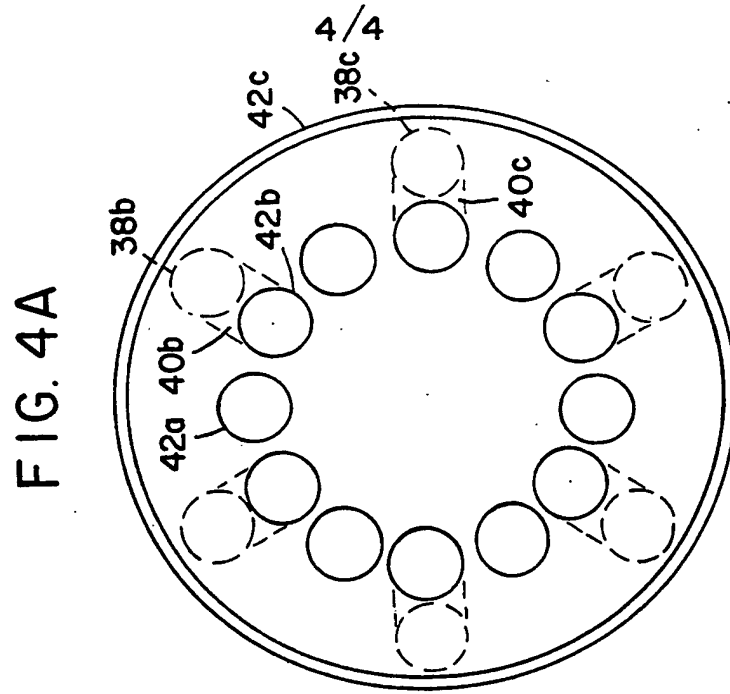
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**FIG. 3**

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US94/05938

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : B29C 47/04, 47/12

US CL : 264/176.1; 425/132; 426/516

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 264/75,176.1,245; 425/132,206,207,463,464; 426/516

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,190,706 (KNAUS) 02 MARCH 1993 , abstract, fig.5	1-6
A	US, A, 3,876,743 (SODERLUND ET AL) 08 APRIL 1975	1-6
A	US, A, 2,858,217 (BENSON) 28 OCTOBER 1958	1-6

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Date of the actual completion of the international search

30 August 1994

Date of mailing of the international search report

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